Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Chemistry

Advanced Subsidiary

Unit 3: Chemistry Laboratory Skills I

Tuesday 7 January 2014 – Afternoon
Time: 1 hour 15 minutes

Paper Reference
WCH03/01

Candidates may use a calculator.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 50.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, including your use of grammar, punctuation and spelling.
- A Periodic Table is printed on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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6/6/6/6/2/2/3/

P 4 2 9 7 4 R A 0 1 1 6

PEARSON

Answer ALL the questions. Write your answers in the spaces provided.

1 A series of tests was carried out on **X**, a white solid, which is known to contain one cation and one anion.

(a) **X** gave a pale green colour in a flame test. Give the name or formula of the cation in **X**.

(1)

.....

(b) When dilute nitric acid was added to a sample of solid **X**, no reaction occurred. Suggest the name or formula of an anion that could **not** be present in **X**.

(1)

.....

(c) Dilute nitric acid was added to an aqueous solution of **X**, and then aqueous silver nitrate was added to the mixture. A white precipitate formed, which dissolved in dilute aqueous ammonia.

Give the name or formula of the anion in **X**.

(1)

.....

(d) A sample of the white precipitate in (c) was left to stand in sunlight.

(i) What colour change would be seen?

(1)

.....

(ii) Name the substance responsible for the new colour that appeared in (d)(i).

(1)

.....

(e) **Dilute** sulfuric acid was added to an aqueous solution of **X**.

(i) What change would be observed?

(1)

.....

(ii) Write an equation for the reaction in (e)(i). Include state symbols.

(2)

(f) (i) A few drops of **concentrated** sulfuric acid were added to a small portion of **solid X** in a test tube. Misty fumes, but no other vapours, were seen.

Identify these fumes by name or formula.

(1)

.....

(ii) Describe a further **chemical** test to confirm the identity of the gas responsible for the misty fumes.

Give the expected result of the test.

(2)

Test .....

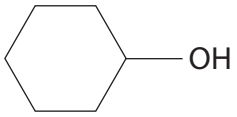
.....

Result .....

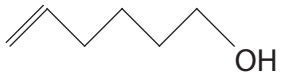
.....

(Total for Question 1 = 11 marks)

2 The skeletal formulae of two compounds with molecular formula $C_6H_{12}O$ are shown below.



cyclohexanol



hex-5-en-1-ol

(a) Each of the compounds reacts when warmed with a mixture of potassium dichromate(VI) and sulfuric acid.

(i) What colour change is seen during this reaction?

(1)

From ..... to .....

(ii) One of the compounds forms a carboxylic acid when it is heated under reflux with a mixture of potassium dichromate(VI) and sulfuric acid.

Give the **structural** formula of this carboxylic acid.

(1)

(b) Under suitable conditions, each of the compounds reacts slowly with a small piece of sodium to form a sodium salt and one other product. Give **two** observations you would make when this reaction occurs.

(2)

Observation 1 .....

.....

Observation 2 .....

.....

(c) Hex-5-en-1-ol can be distinguished from cyclohexanol by its reaction with aqueous bromine.

(i) What colour change would be seen in this reaction when hex-5-en-1-ol is used?

(1)

From ..... to .....

(ii) Complete the skeletal formula below to show the product of this reaction.

(1)

(d) Hex-5-en-1-ol reacts with acidified potassium manganate(VII) at room temperature.

(i) What colour change would be seen in this reaction?

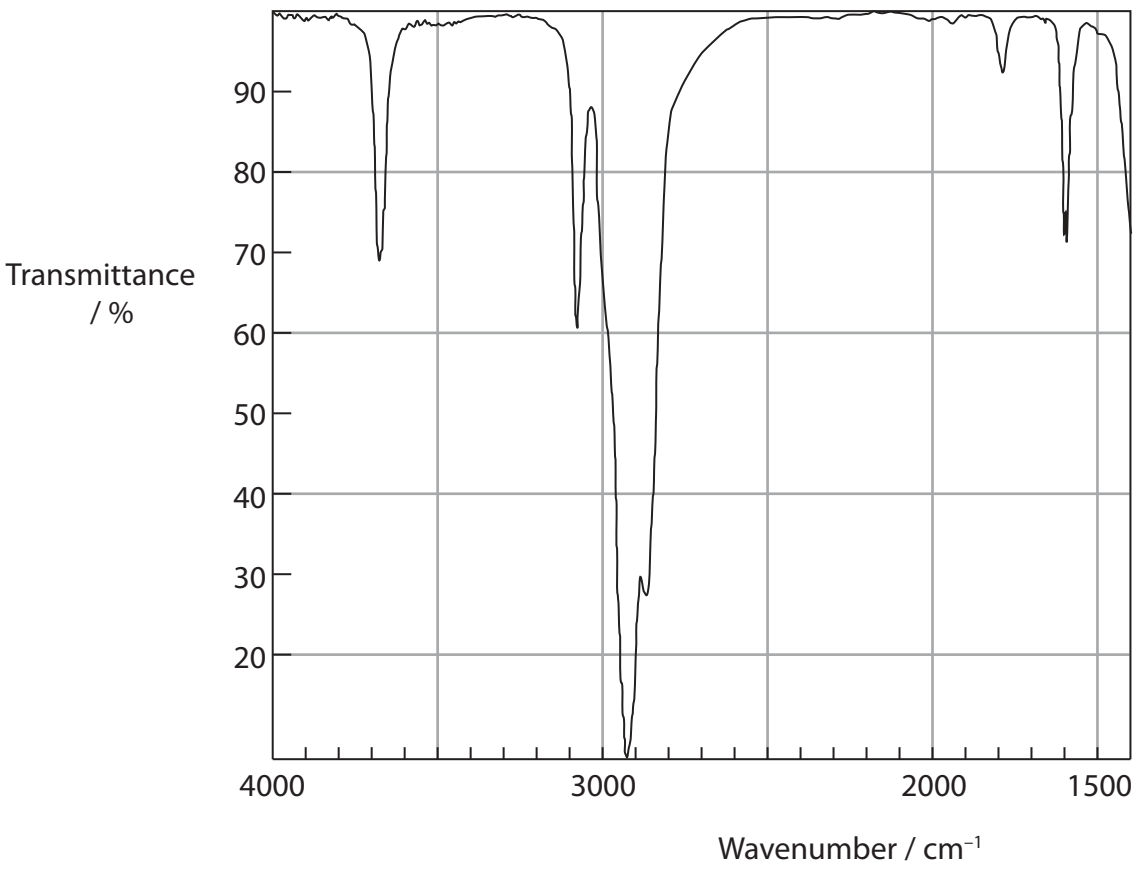
(1)

From ..... to .....

(ii) Complete the skeletal formula below to show the product of this reaction.

(1)

(e) The infrared spectrum below is for either cyclohexanol or hex-5-en-1-ol.



For which of the two compounds is this the infrared spectrum? Use **two** pieces of data from the table below to justify your answer.

Bond	Wavenumber / cm^{-1}
C—H stretch, alkane	2962–2853
C—H stretch, alkene	3100–3010
C═C stretch, alkene	1669–1600
O—H stretch, alcohols	3750–3200

(2)

Spectrum is for .....

Justification: .....

.....

.....

(Total for Question 2 = 10 marks)

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3 The mass of magnesium hydroxide, $Mg(OH)_2$, in an indigestion tablet was determined as follows:

Step 1 The tablet was crushed and dissolved in exactly 40.00 cm^3 of dilute hydrochloric acid (an excess).

Step 2 The amount of hydrochloric acid remaining was measured by titration with 0.250 mol dm^{-3} sodium hydroxide solution.

22.80 cm^3 of this sodium hydroxide solution was required.

$$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$$

(a) (i) A student suggested using Universal Indicator for the titration. Why would this indicator be unsuitable?

(1)

.....

.....

(ii) Suggest a suitable indicator and give its colours in acidic and alkaline solutions.

(2)

Indicator .....

Colour in acid .....

Colour in alkali .....

(b) (i) Calculate the number of moles of sodium hydroxide used in the titration.

(1)

(ii) Hence state the number of moles of hydrochloric acid that react with the sodium hydroxide in (b)(i).

(1)

(iii) The amount of acid added to the tablet in **Step1** was 2.00×10^{-2} mol. Use this information and your answer to (b)(ii) to calculate the number of moles of hydrochloric acid that reacted with the tablet.

(1)

(iv) The equation for the reaction of the magnesium hydroxide in the tablet with hydrochloric acid is shown below.

$$Mg(OH)_2(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + 2H_2O(l)$$

Calculate the mass of magnesium hydroxide in the tablet. Give your answer to **three** significant figures.

The molar mass of magnesium hydroxide is 58.3 g mol^{-1}.

(2)

(c) The volume of hydrochloric acid added to the tablet was 40.00 cm^3.

(i) Suggest a change in the procedure which would make the result of the experiment **more reliable** for each tablet which is analysed.

(1)

.....

.....

.....

.....

(ii) The hydrochloric acid was measured using a burette. Each time the burette was read, the error was ± 0.05 cm^3. Calculate the total percentage error in measuring 40.00 cm^3 of hydrochloric acid.

(2)

(d) When an indigestion tablet reacts with hydrochloric acid in the stomach, it is important that the reaction is not too exothermic.

The enthalpy change of this reaction can be determined by reacting magnesium hydroxide with an excess of hydrochloric acid in an insulated container and measuring the maximum temperature change.

State **two** ways, other than improvements in insulation or use of more accurate measuring instruments, which would ensure that the measured temperature change was the **maximum** possible for the amounts of reactants used.

(2)

1 .....

.....

.....

2 .....

.....

.....

(Total for Question 3 = 13 marks)

4 Cyclohexene, C_6H_{10}, can be prepared from cyclohexanol, $C_6H_{11}OH$, using the procedure below.

Step 1 Place 0.100 mol of cyclohexanol in a flask and add about 4 cm^3 of concentrated phosphoric(V) acid, drop by drop, while shaking the flask.

Step 2 Assemble the flask for distillation, and collect the liquid which distils over between 70 °C and 90 °C.

Step 3 Add the distillate to an equal volume of a saturated solution of sodium chloride. Shake the mixture, allow the layers to separate, and discard the aqueous (sodium chloride) layer.

Step 4 Transfer the layer containing cyclohexene into a small flask. Add a few pieces of a solid drying agent to the crude cyclohexene, stopper the flask and shake it for a few minutes.

Step 5 Decant the crude liquid alkene and carry out a final purification in order to obtain pure cyclohexene.

(a) (i) Use the formulae of the reactant and product to deduce the role of phosphoric(V) acid in this reaction.

(1)

.....

(ii) Suggest the main hazard when using concentrated phosphoric(V) acid in this preparation.

Give **one** precaution which should be taken when using it, other than the use of safety goggles and a laboratory coat.

(2)

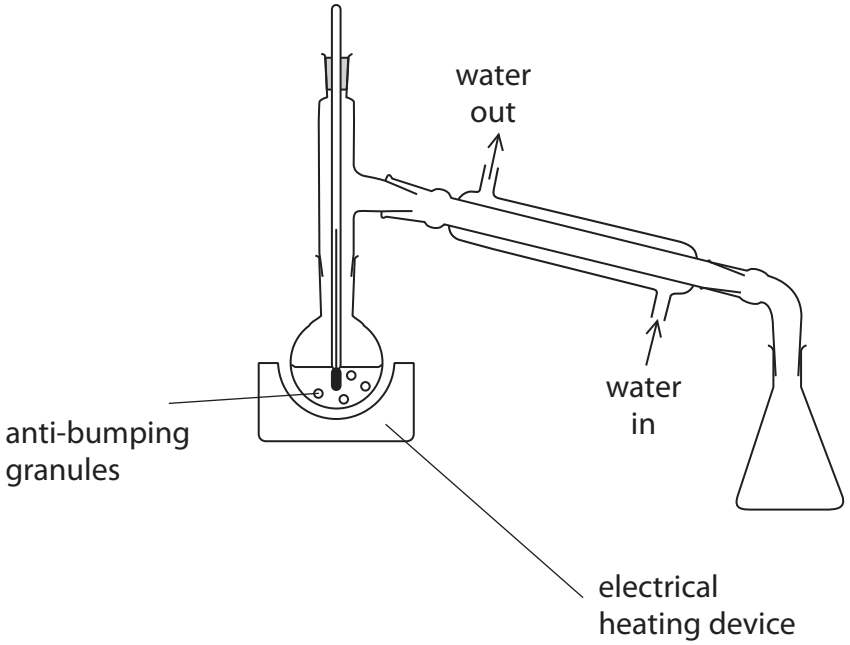
Hazard .....

Precaution .....

(b) A student suggested using the apparatus shown in the diagram below to carry out **Step 2**.

Describe **two** ways in which this apparatus must be modified for safe and efficient use in **Step 2**. Assume the apparatus is suitably clamped.

(2)



1 .....

.....

2 .....

.....

(c) (i) Cyclohexene can be separated from other products in **Step 3** because it is insoluble in aqueous solutions.

Explain this lack of solubility.

(2)

.....

.....

.....

.....

.....

.....

(ii) Draw a diagram of the apparatus which should be used in **Step 3**.

Label the cyclohexene layer.

Data

Substance	Density / g cm^{-3}
Cyclohexene	0.81
Saturated sodium chloride solution	1.20

(2)

(d) (i) Suggest a suitable solid drying agent to use in **Step 4**.

(1)

.....

(ii) What change would you see in the appearance of the organic liquid when it is dried in **Step 4**?

(1)

.....

.....

(e) Suggest a method for the final purification of the crude cyclohexene in **Step 5**.

(1)

.....

(f) (i) Calculate the volume of 0.100 mol of cyclohexanol, $C_6H_{11}OH$.

The density of cyclohexanol is 0.962 g cm^{-3}.

(2)

(ii) After final purification, the yield of cyclohexene was 5.50 g.

Calculate the percentage yield in this reaction. Each mole of cyclohexanol can give a maximum yield of one mole of cyclohexene.

(2)

(Total for Question 4 = 16 marks)

TOTAL FOR PAPER = 50 MARKS

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8) (18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)		Key									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4		relative atomic mass **atomic symbol** name atomic (proton) number									10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.9 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	95.9 Mo molybdenum 42	[98] Tc technetium 43	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La* lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111							

Elements with atomic numbers 112-116 have been reported but not fully authenticated

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	[147] Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	163 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	[231] Pa protactinium 91	238 U uranium 92	[237] Np neptunium 93	[242] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[245] Bk berkelium 97	[251] Cf californium 98	[254] Es einsteinium 99	[253] Fm fermium 100	[256] Md mendelevium 101	[254] No nobelium 102	[257] Lr lawrencium 103

* Lanthanide series

* Actinide series